Detection and Measurement of Explosives in Groundwater Using In Situ Electrochemical Sensors

Cleanup
CU-1220

Background:

Since World War I, munitions have been manufactured in the United States using a variety of modern highly energetic materials, including propellants, explosives, and pyrotechnic materials. Many of these manufacturing sites contain explosives-contaminated soil and have contaminated groundwater as a result of prior and existing operations - including load, pack and repack, maintenance, storage, disposal, and demilitarization. It is estimated that 1,300 installations worldwide containing approximately 5,500 individual sites contaminated with various compounds will require some form of remedial actions. A significant portion of this contamination is due to past practices for disposal of explosives. Congress has mandated that the Army and other services comply with all applicable environmental laws and regulations at these contaminated sites to ensure protection of human health and the environment.

Objective:

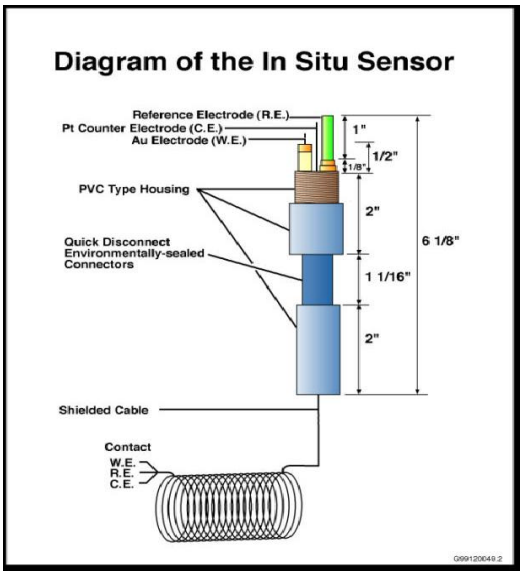
The objective of the proposed research is to develop in situ sensors capable of replacing conventional methods (sample collection and analysis) for measuring concentrations of 2,4,6-trinitrotoluene (TNT), rapid detonating explosive (RDX), high melting explosive (HMX), tetryl, and nitrocellulose in groundwater at 20-50 ppb levels with long-term stability (years). This approach can be used in existing groundwater monitoring wells and may be capable of installation in explosives contaminated groundwater using direct push technology.

Summary of Process/Technology:

This technology is based on electrochemical detection and relies on using a gold and/or carbon fiber working electrode and square-wave voltammetry. The detection scheme is based on an electron-transfer process and involves an initial reduction of the nitro aromatic groups on the explosive molecule to hydroxylamines, followed by the conversion of the latter to amine groups. The reduction potential provides the method selectivity for a specific explosive, and the current required per unit time determines the concentration of the targeted explosive in an aqueous media. In order to evaluate the capabilities of this technology for long term monitoring, several specific activities are planned. This includes evaluation of electrode material, detection limits for various explosives, electrode long-term stability, and effects of co-contaminants or explosive decomposition products present in groundwater.

Benefit:

If the technical goals of this project are achieved, there are significant paybacks in cost savings to the Department of Defense (DoD). A significant portion of DoD's restoration budget goes for long-term monitoring costs. Most of the cost is associated with the collection of samples, disposal of purge water, and subsequent sample analysis. This cost will only continue to increase as more sites are added to the cleanup list. In situ sensors offer an alternative to routine sampling and analysis and can result in significant long term cost savings to military installation in and outside the U.S.



Accomplishments:

This is an FY 2001 New Start project.

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